Answering the criticisms raised in *Futuribles* (October 2007)

A recent article in *Futuribles* by Frédéric Paul Piguet, Isabelle Blanc, Tourane Corbière-Nicollier, and Suren Erkman from the University of Lausanne and École des Mines ("L'empreinte écologique: un indicateur ambigu" October 2007) claims that the Ecological Footprint provides a poor and even misleading answer to its research question *of how much of the planet's regenerative capacity people are using*. While the study raises many important issues, a large number of the author's claims are based in misunderstandings or distortions of what the Footprint method actually does..

To clarify the issues, the following table addresses each of the issues raised by Piguet et al. The first column quotes the original French text, and the second column provides an English translation, editedto facilitate comprehension. Valid criticism can either question the usefulness, relevance and logical consistency of the research question; or it can question the quality of the answer to the research question. Therefore, we answer the authors' statements either by explaining why the research question is valid, or why the answer is consistent with the research question.

If you still have questions or are not satisfied with answers, please send your comments, indicating the URL of the page, to info@footprintnetwork.org.

Page and Para.		**Critiques (FRANÇAIS)**	**Criticism (ENGLISH translation – and slightly edited for clarification)**	**Global Footprint Network Reponses**
4	2	La liste des éléments ignorés par l'empreinte concentre ainsi la majeure partie des problèmes écologiques.	Elements ignored by the Ecological Footprint calculations represent the majority of today's ecological problems.	Environmental challenges can be divided into two categories: a) toxics and pollution, often with direct threats to human health, and b) over-exploitation of resources and biological capacity, or threats to the ecosystems (croplands, fisheries, forests, etc.) that form the direct underpinning of human well-being. While the environmental community in the twentieth century largely focused on problems in the former domain (and many measurement tools and regulations are now in place to attack those), the sheer scope and scale of the human economy has made the latter domain more and more relevant. We believe that this over-exploitation poses a large, underestimated risk to humanity in the twenty first century. The Ecological Footprint framework was specifically conceived to address this latter domain. It is an answer to a specific, well-defined research question ("How much of the regenerative capacity of the biosphere is occupied by human activities?"). It is this research question that is the "DNA" of Footprinting science. We believe that this question is absolutely core to any meaningful sustainability assessment. We explicitly state (including in the Footprint standards at www.footprintstandards.org) that the Footprint only covers use of those materials that are biological in nature, consistent with its focus on the use and availability of ecosystem goods and services. In contrast, those aspects that are inherently unsustainable need to be phased out, and are not captured by the Footprint. For instance persistent pollutants such as CFCs, PCBs, or heavy metals are not covered by

				the Footprint research question. They need to be addressed primarily with other measures. The effects on ecosystems associated with these toxic materials, however, are reflected indirectly in Ecological Footprint accounts through both the biological capacity required for their creation (e.g., energy and built-up land area) and the eventual decrease in ecosystem production that results when they are released into the environment. .
4	3	Le GFN est conscient que le calcul de la biocapacité n'intègre pas la préservation des surfaces nécessaires à la diversité biologique.	Global Footprint Network is conscious that the measure of biocapacity does not include the necessary area set aside for biodiversity.	We explicitly note and recognize that it takes a portion of biocapacity for wild species to thrive, but we do not judge how much since it depends on the desired outcome. What we offer is a framework that allows for the discussion of how much of the biocapacity should be set aside for maintaining biodiversity. Some conservation biologists, such as E.O.Wilson, suggest leaving as much as 50 percent of the biosphere for wild species. Similarly, hotspot approaches indicate how smaller amounts could still conserve significant portions of biodiversity. As particular amounts are chosen for biodiversity preservation, they can be accounted for in the biocapacity section of Ecological Footprint accounts. Ecological Footprint numbers give a good overall indication of human pressure on biodiversity. Therefore, the largest conservation organization on this planet, WWF, is actively using the Ecological Footprint in their conservation and policy work.
4	3	La biocapacité est pensée dans la perspective de la mise en valeur économique de la totalité des 11,2 hag considérés. L'empreinte implique ainsi une rationalisation extrême du territoire puisqu'un espace dévolu principalement à la diversité biologique amoindrirait la biocapacité planétaire.	Biocapacity is biased towards "economic exploitation" of the 11.2 gha considered. The Footprint thus implies an intensive, utilitarian land-use scheme, since any land set aside for biocapacity would lessen global biocapacity.	This is an incorrect statement. If biocapacity is set aside for non-exploitative purposes, such as parks or preservation, its biocapacity value does not change. Rather this simply means that this capacity is not being harvested by humans. Note that the regenerative capacity of non-exploited areas is accounted for in the biocapacity side of the accounts, not in the Footprint calculations.
4	3	Certes, le *Rapport planète vivante 2006* est publié en association avec la Société zoologique de Londres qui y expose ses recherches sur l'érosion de la diversité biologique, mais sa perspective n'est ni celle du consommateur ni celle de la nation, alors que le GFN en fait ses points d'entrée privilégiés. Il n'y a donc pas de lien organique véritable qui permettrait aux propos de la Société	The *Living Planet Report 2006* is published in association with the Zoological Society of London, where it exposes its research on biodiversity loss (with the LPI). But the target audience for the LPI is neither the consumer nor the nation, whereas Global Footprint Network clearly targets these audiences. There is therefore no real authentic link between LPI and Footprint where the	The current Living Planet Index (LPI), produced by the Zoological Society of London and WWF, looks at global trends. Some newer studies analyze the LPI of continents or countries, allowing for the identification of possible correlations between declining LPI and local overshoot, as measured by the Footprint. The Footprint is correlated with the five main threats to biodiversity, and so provides a good proxy measure for biodiversity threat. This is why the Convention on Biological Diversity has adopted the Footprint (and the Living Planet Index). Note that the global LPI and Footprint trends show an inverse correlation: as the Footprint has increased, the LPI has decreased.

		zoologique de Londres de suppléer à l'insensibilité de l'empreinte concernant la diversité biologique.	Zoological Society of London can supplement the inadequacies of the Footprint for biodiversity issues.	
4	4	Des auteurs extérieurs au GFN, tels Jeroen van den Bergh et Herman Verbruggen, relèvent que l'agrégation de données hétérogènes est le problème principal de l'empreinte.	Other authors such as Jeroen van den Bergh and Herman Verbruggen point out that the aggregation of heterogeneous data is the main problem of the Ecological Footprint.	The Ecological Footprint is an accounting system that aggregates competing demands on the biosphere. It is similar to other accounting systems that aggregates value added (GDP), carbon (carbon accounts), or material flow (material flow analysis) data. Like any true accounts, Footprint accounts do not assign arbitrary weights to individual components in order to add them together, but rather, all the different types of land and sea area that are demanded are normalized to the common unit based on empirical data: the relative productivity of these different area types. This normalization is not arbitrary and is based on observable characteristics of the land and sea areas. Note the distinction between ***accounting systems*** and ***score-cards.*** The latter arbitrarily (and hence unscientifically) aggregate different issues, and accounting systems that add up similar things in a consistent framework. –Examples of accounting systems include money (GDP), carbon, greenhouse gases, energy consumption, or global hectares. Surely there are data challenges, but conceptually, adding up and comparing global hectares is scientifically sound and not heterogeneous. We recommend expressing results in terms of global hectares since we are comparing bioproductivity (related to the quality of the land type) rather than just the surface area of the planet. *Global* hectares provide a useful representation of the ecological demand associated with the use of a product, as they measure how much of global biological productivity is required to produce this demand. They provide more information than simply material weight (which does not capture the extent of land and sea area used) or physical area (which does not capture how much biological production is associated with that land). *Global* hectares are particularly useful for ranking different products based on their total biological demands across types of land, such as wheat and wood.
4	4	Par exemple, l'*espace construit* reçoit un poids identique à l'*espace cultivé* malgré des caractéristiques environnementales opposées.	For example, the built-up land area receives an identical weighting to the cropland area, despite having very different environmental attributes.	In our current ecological services accounts, we include built-up area in terms of compromised biocapacity. For instance, we could have chosen to produce potatoes on some particular piece of the land, but now we use it for sub-urban houses and their recreational gardens. As a first approximation, confirmed by much other research, urbanized areas are typically located on prime agricultural land. In our current national accounts we account for them as if they were average cropland, probably underestimating the biocapacity being compromised by built-up area. If we had more specific data on what kind of land is being urbanized, we could include such data in the accounting framework.
4	4	De plus, l'importance accordée aux différentes dimensions physiques «	Furthermore, the importance attributed to different physical	While the calculation of equivalence factors for comparing different land types can certainly still be improved, the calculation is based on an ecological analysis, not a

		ne correspond pas nécessairement aux critères sociaux. En d'autres termes, celles-ci ne reflètent ni les changements de la rareté relative au cours du temps ni la variation selon l'espace. »6 L'empreinte ne distingue pas si un espace est exploité de manière durable ou non, la mesure demeure *hypothétique* faute de refléter la qualité *et* la quantité des ressources employées.	dimensions does not necessarily correspond to social criteria. In other words, there is neither reflection of the changes in the relative scarcity, nor of spatial variation of physical resources. The Footprint does not distinguish whether space is exploited in a sustainable manner or not: the measure remains hypothetical because it does not reflect the quality and the quantity of the used resources.	social one. It helps compare productivity of one land type against another. Equivalence factors are recalculated for each year, hence reflecting the changes in land use and technology. Further, if land area is degraded, this will erode the biocapacity and show up as lower biocapacity in future years. It is important to also note that we can distinguish harmless and potentially destructive Footprints as we go into more detail. However, we never use the word "sustainable" to describe the quality of land use. First of all, "sustainable" is a description of systems, and secondly, we are using the Footprint to give meaning to the word sustainable. Otherwise the argument becomes circular. In short, yes we measure quantity, and we contend that in a world affected by overshoot, we cannot get quality right if we do not get quantity right, otherwise we just displace one problem with another. In a resource-constrained world, "quantity trumps quality." And yet we also need to get quality right – using complementary measure to track progress.
		Valérie Boisvert montre d'ailleurs que l'empreinte n'est pas en prise avec le territoire concret : Il ne s'agit pas de mesurer quel est l'espace effectivement utilisé par des activités et des implantations humaines mais d'exprimer leur demande théorique d'un espace standardisé qui aurait une productivité biologique égale à la moyenne annuelle mondiale.	Valérie Boisvert shows that the Footprint does not represent any actual territory: It does not measure the area actually used by human activities and developments, but rather expresses their theoretical demand on a standardized area which has a biological productivity equal to the annual world average.	This is a misconception. Just as financial analyses are expressed in a common currency (Dollars or Euros, etc), Footprint assessments are based on global hectares. Specific local hectares for both Footprint and biocapacity values are translated into global hectares using *nation-specific* yield factors and global equivalence factors. While the *yield* factor allows a conversion of the actual area requirement to global averages (in that land use category), the *equivalence* factor is used to translate specific land use categories into average bioproductive surface area. Thanks to these factors, every global hectare can therefore be translated into the corresponding number of specific local hectares, without loosing information about the local particularities (Galli et al., 2007).
4	5	Van den Bergh et Verbruggen s'élèvent contre le découpage spatial de l'empreinte. Les frontières nationales n'ont pas de signification environnementale lorsqu'elles traversent des écosystèmes interconnectés.	Van den Bergh and Verbruggen do not support the spatial segregation of the Footprint. National boundaries do not have any environmental significance when they cross over interconnected ecosystems.	This is a misconception. Are farm boundaries meaningless? No, they tell the farmer where they can and cannot graze their cattle and grow their crops. The same is true for the Footprint and biocapacity: biocapacity tells us how much capacity is within the boundaries of a country (similar to a farm) and the Footprint tells us how much the population uses compared to that capacity.
4	5	L'empreinte écologique déficitaire des régions ou villes très peuplées n'est pas un signe de non durabilité mais le résultat d'une spécialisation des espaces terrestres non dommageable en soi.	The ecological deficit of regions or highly populated areas is not a sign of unsustainability, but rather the result of a specialisation of terrestrial spaces, which is not in itself a detrimental occurrence.	We are not making this claim. An ecological deficit in itself is neither sustainable nor unsustainable. A deficit is compensated either through imports or depletion of one's ecological assets (the latter would not be sustainable). But imports can be sustainable if there is enough biocapacity in the world to provide this import. Thus, regions cannot be looked at in isolation from what is happening at the global scale. Since the Earth is a materially closed thermodynamic system, it is not possible to import biocapacity from the outside (unless it can be brought at reasonable costs from other planets). In

				the context of global overshoot, running increasing local deficits becomes a serious sustainability challenge.
5	2	Les forêts semblant avoir un fort potentiel de séquestration du carbone, le GFN les a sélectionnées comme espace de référence pour estimer l'*empreinte carbone*, soit la surface biologiquement productive capable de séquestrer les émissions de carbone anthropogène. Selon Van den Bergh et Verbruggen, qui remettent en cause ce choix, le calcul de l'empreinte carbone dénoterait le projet d'étendre les surfaces forestières afin de séquestrer du carbone, ce qui serait non praticable et « irréaliste dans une perspective économique »..	Global Footprint Network has selected forests that seem to have a strong sequestration potential as a reference area for estimating the carbon Footprint, i.e., the biologically productive surface capable of sequestering anthropogenic carbon emissions. According to van den Bergh and Verbruggen, who question this choice, the calculation of the carbon Footprint, which promotes aforestation for sequestering carbon, would be both impractical and economically unrealistic.	The Ecological Footprint in no way advocates planting forests as the primary solution to climate change. The results actually point out the opposite - that at present, the biosphere is unable to cope - either through forest growth or other measures - with the large amounts of carbon dioxide emitted by human activities. The accounts reflect this state by showing a large demand for CO_2 sequestration capacity in excess of what is available. Thus Footprint results are consistent with Piguet et al.'s claim in recognizing that clearly the biosphere is unable to address anthropogenic emissions of carbon today, and that aforestation is not a viable solution. Moreover, the carbon Footprint calculation is done by assessing the land area required to sequester, through photosynthesis, that part of the CO_2 emissions from fossil fuel combustion which is not absorbed by the oceans (according to the IPCC, oceans are currently able to absorb about 30% of total human emissions) and not sequestered away from the biosphere through other measures, such as carbon capture and storage. To calculate the current capacity of world average forests to sequester carbon, a method based on the IPCC estimates of annual average aboveground biomass growth on forested land, and areas of forests, as reported by the United Nations Food and Agriculture Organization (FAO), is used. To calculate the sequestration rate, the total area of various types of tropical, temperate, and boreal forests are extracted from the FAO document *State of the World's Forests* (approximately 3.4 billion hectares total). An average annual production of biomass (measured in dry matter) in each of eight different forest types is then calculated using IPCC reported yield data for each forest type (tonnes of biomass in dry matter equivalent that is grown aboveground per hectare per year) and FAO area data. Total annual production for global forests is then calculated by summing the annual production of each of these eight forest types. The average sequestration rate is therefore calculated by dividing total annual production by the total forested area of Earth and is dependent on forests' type and their growth rates.
5	2	Ce choix est aussi vivement critiqué par Robert U. Ayres qui préfère s'en remettre aux technologies de séquestration et aux énergies nouvelles.	This choice is also firmly criticized by Robert U. Ayres who prefers to rely on sequestration technologies and new energy sources.	The Footprint does not measure what could be, but what is. Once we use these technologies we will include the Footprint of those choices to the extent that they are applied. Now we essentially act as if nature could handle our waste stream by blindly pumping excess CO_2 into the atmosphere. Hence we need to know how many ecological services humanity is using compared to how many of these services nature can sustainably provide.
5	2	Cet ensemble de critiques ne semble toutefois pas fondé puisque les représentants du GFN proposent un large panel de solutions. L'empreinte carbone doit ainsi être entendue comme une manière	The above body of criticism however does not seem well-founded since Global Footprint Network representatives propose a wide panel of solutions. The carbon Footprint should also be understood as a way	This statement is absolutely correct.

		d'exprimer les émissions de carbone par une mesure standardisée de l'espace biologiquement productif, non comme un projet de reforestation.	of expressing carbon emissions as a measure of biologically productive land and not as a reforestation project.	
5	3	Une critique reprise par maints auteurs (van den Bergh & Verbruggen, Ayres, Boisvert) est que l'empreinte incite les différents pays à l'autosuffisance écologique, c'est-à-dire à n'utiliser pas plus de ressources environnementales qu'ils n'en disposent.	A criticism that has been repeated by several authors (van den Bergh and Verbruggen, Ayres, Boisvert) is that the Footprint encourages different countries to be ecologically self-sufficient - to not use more environmental resources then they possess.	This does not apply and is a misguided criticism by van den Bergh and Verbruggen, Ayres, and Boisvert. Footprint accounting does not imply any normative action. It just describes human demand on nature and availability of nature. The authors themselves acknowledge that this criticism is misguided and refer to the *Living Planet Report 2006*.
5	4	***L'empreinte écologique incite-t-elle à la déforestation ?*** Un indicateur ne doit pas provoquer des effets contraires aux objectifs prescriptifs qui le soustendent. Les indicateurs peuvent aussi mener à des politiques contreproductives sans qu'aucun artifice ne soit mis en oeuvre.	***Does the Ecological Footprint incite deforestation?*** An indicator should not provoke contrary effects to the objectives that prescribe it. Indicators can also lead to counter-productive policies without explicit implementation.	This is a surprising claim, and is not consistent with our analysis. Of course, optimizing just one indicator can lead to perverse outcomes. The level of perverse outcomes that would be generated with the Footprint is minor compared to the perverse outcomes that GDP or carbon accounting can induce. For example, carbon accounting alone is blind to the devastating effects of palm-oil based bio-diesel or ethanol sources' competition for land. The Footprint captures these effects.
5	4	C'est le cas de l'empreinte qui pourrait permettre à nombre de compagnies forestières ou agricoles d'arguer que le remplacement des forêts par des cultures améliore la balance écologique de certains pays.	If the above is true, the Ecological Footprint could allow forestry and agricultural companies to argue that the replacement of forests by cropland would increase biocapacity.	In theory, the way biocapacity accounting is constructed, a hectare moved from forest to cropland should not change the biocapacity measured in global hectares. This is exactly why we have introduced yield and equivalence factors. At the margin, converting a hectare of forest into cropland looks as follows: a hectare of forest with a relatively high yield factor (i.e., an over average productive forest hectare) will be turned into a lower than average productive crop hectare (i.e., a less than average productive cropland area). In other words, the reduction in the yield factors should compensate for the increase in the equivalence factor. In practice, this is not exactly the case, which should be improved. But it is also not the case that converting forests to other land uses will always show up as in increase in biocapacity. In the real accounts, the inverse can also occur. Further, any Footprint can also be analyzed on the desirability of each element: one can distinguish among the various area types and areas occupied and decipher which uses are restorative and which lead to degradation of ecosystem assets or characteristics. For instance, consuming soy with a cropland Footprint that has been converted from tropical rain forest would also have significant biodiversity impacts. In other words, the specific impacts of each element of the Footprint can be identified in a second level analysis.

5	5	La compréhension de ce point nécessite quelques précisions. La biocapacité équivaut au niveau maximal de production des ressources d'origine biologique. Elle comprend le potentiel de production des zones non exploitées, qu'elles soient éloignées, protégées, ou simplement négligées. Elle n'intègre pas l'énergie et la matière comprises dans l'écorce, les feuilles et les racines, lorsque ces éléments sont définis comme inutiles au sens de l'économie humaine. La biocapacité relève de la quête d'un agro-écosystème idéal visant à maximiser la production écologique planétaire.	The understanding of this point requires a few further explanations. Biocapacity equals the maximum production level of biological resources. It comprises the production potential of non-exploited zones, be they far away, protected or simply neglected. It does not integrate the energy and materials embodied in bark, leaves and roots, since these elements are considered useless to the human economy. Biocapacity picks up on the quest for an ideal agro-ecosystem, which aims to maximise global ecological production.	This is an incorrect claim. The Footprint in itself does not argue for maximizing exploitation, but gives an upper limit for exploitation. It also makes clear that as more of the biocapacity is used by humans, less capacity is available for wild species. Clearly, this puts biodiversity at risk.
7	1	Le tableau 1 indique clairement qu'un certain nombre de pays peuvent améliorer leur biocapacité en remplaçant une partie de leurs forêts par des cultures	Table 1 in the *Futuribles* article clearly indicates that a certain number of countries can increase their biocapacity by turning a portion of their forests into cropland.	This assessment is incorrect. As explained above, global hectares are constructed so that land conversion should not change biocapacity. Poor management practice can and often does reduce biocapacity, but the inherent capacity of land could serve different uses without changing biocapacity. The present implementation of "global hectares" may not be perfect yet, but it is close: it can show maintenance of biocapacity even if land is being converted. In contrast, the authors' approach is flawed because they assume fixed and location-unspecific yield factors. In reality, one would need to analyze the exact yield factor for each hectare of converted land as land-use change takes place. As a result of using correct yield factors, a hectare converted should, in first approximation, maintain its value of "global hectares."
8	2	L'objectif assigné à ce programme [GAEZ] est la détermination du potentiel agricole à disposition des 9 milliards d'habitants prévus à l'horizon 2050. Il s'agit d'éviter que les pauvres pâtissent d'un manque de nourriture faute d'une augmentation adéquate de la production; cette problématique a une forte dimension sociale, mais le GFN l'a importée pour estimer le dépassement des limites écologiques planétaires. Ce constat nous permet d'esquisser la thèse selon laquelle l'empreinte	The objective of GAEZ is to determine the agricultural potential available to the 9 billion inhabitants expected for 2050 and avoid suffering from food shortage due to an insufficient increase in production. This issue has a strong social dimension, but Global Footprint Network has used it only to estimate the overshoot of ecological limits. Therefore we claim that the Footprint conceptually suffers from inadvertently linking famine and food distribution issues with	Our accounts compare supply with demand in any given year. They do not make social judgments about fairness of distribution, but simply document who uses what. We are not convinced by Piguet et al.'s argument that GAEZ leads to excessive skewing of the results: We believe that the GAEZ data set is a useful first approximation of a systematic biocapacity assessment, and while it is not perfect, we have so far not found a better substitute. If there were better data sets, we would use those, but we are limited by the data sets available. We are also studying the use of NPP data, an approach we took before applying GAEZ data sets. But we have found that NPP data sets are more problematic than GAEZ: they provide less consistency in data sets, and are more ambiguous when comparing supply against demand than in the case of agricultural and forest data.

		souffre de l'association irréfléchie d'une problématique du respect de la Biosphère avec celle du partage de son usufruit en faveur des plus pauvres.	agricultural productivity.	
8	3	Notre présentation des données du *Rapport planète vivante 2006* diffère de celle du GFN afin de clarifier les enjeux réels de l'empreinte (tableau 2). Les totaux sont les suivants : la colonne biocapacité indique un total de 1,78 hag *per capita*, l'empreinte écologique se monte à 2,23 hag *per capita*. La balance écologique est donc établie par soustraction à -0,45 hag *per capita* (1,78 - 2,23 = -0,45). Les *dépenses écologiques* excèdent ainsi le *revenu écologique* de 25%. Mais le détail du tableau nous réserve quelques surprises. La biocapacité de l'espace bâti est chiffrée à 0,08 hag *per capita* et équivaut exactement aux 0,08 hag de l'empreinte bâti, d'où une balance écologique parfaitement équilibrée.	Our presentation of the data from the *Living Planet Report 2006* differs from that of Global Footprint Network so as to clarify the real stakes of the Footprint (table 2). The totals are as follows: the biocapacity column indicates a total of 1.78 gha per capita, the Ecological Footprint reaches 2.23 gha per capita. The ecological deficit is therefore -0.45 gha per capita (1.78-2.23). The ecological expenditures thus exceed ecological revenue by 25%. However the detail of the table contains a few surprises. The biocapacity of built-up land is 0.08 gha per capita which is exactly equal to the Ecological Footprint of 0.08 gha per capita, thus giving a sense of perfect ecological balance.	The authors misunderstand the results. First, it is not about balance, but to what extent human demand is within (that is equal or lower than) the biocapacity. For built-up areas, having equal amounts of biocapacity in the Footprint and biocapacity areas just means that we use as much as we have, which is a basic reality for this land type. This does not infer "ecological harmony" or "balance." It just documents how much biocapacity is compromised by built-up land. Some of the built-up area is paved over (roads), some is fenced-in gardens. Both are excluding other uses and reduce habitat for wild species. This built area had to come from somewhere -- f or example, it could represent areas that were formerly used for crops. And what is now in the crop area is no longer in the forest or grazing area
8	4	En d'autres termes, cette méthodologie attribue une biocapacité à l'espace bâti alors que ce dernier est connu pour être une cause de l'amenuisement des cultures. En fait, le GFN évalue la biocapacité de l'espace bâti à partir du facteur d'équivalence des cultures, les villes étant généralement construites sur les terres agricoles. Aussi, malgré une multiplication par deux de l'espace bâti, la méthodologie actuelle de l'empreinte ne discernerait aucune cause de déficit écologique liée à ce poste. La balance écologique de cet espace serait toujours à l'équilibre	In other words, this methodology attributes biocapacity to built-up land despite a subsequent potential reduction of cropland. In effect, Global Footprint Network evaluates biocapacity using a cropland equivalence factor, since towns are generally built on agricultural land. Also, despite built-up space being multiplied by a factor of two of the, the current methodology does not discern any cause of the ecological deficit to be linked to this phenomenon. The ecological balance of this space will always be perfect (biodiversity of 0.16 gha per capita and an Ecological Footprint of 0.16	There is no contradiction here. This transfer of biocapacity from forest, crop or grassland to built-up area is exactly what we are accounting for. In other words, the former agricultural biocapacity is now compromised by urban use. This is sound accounting and does not distort global overshoot. What we have is what we use in terms of built up land, and the same is obviously true for cropland (with a small difference for fallow land). As with any accounting system, outcome is being documented, not causality. Accounting does not identify causality. This is true for any accounting, including financial accounting. Financial accounts just state the financial health at a given time but do not identify the reasons or decisions that lead to this outcome. Increased built-up surface still leads to further overshoot. Taking land away from other domains puts more pressure on other domains as long as consumption is not reduced. Also, built-up area, once built up, puts further demand on the Footprint for construction and maintenance of the buildings, and the lifestyles they enable. (Note: this further demand is not captured under the rubric "built-up area").

		(0,16 hag per capita pour la biocapacité et 0,16 hag per capita pour l'empreinte écologique). En dépit de cette augmentation de l'espace bâti, la biocapacité planétaire serait inchangée du fait du transfert de la biocapacité agricole vers la « biocapacité » de l'espace bâti. Le déficit écologique planétaire est ainsi diminué de manière artificielle par l'intégration de l'espace bâti dans le compte de la biocapacité.	gha per capita). In spite of the increase in built-up land, global biocapacity would remain unchanged due to the transfer of agricultural biocapacity to the biocapacity of built-up land. The global ecological deficit is thus diminished artificially by the integration of built-up land within the biocapacity account.	
8	5	De manière générale, plus un pays consomme, plus les surfaces bâties répertoriées sont importantes. Les Etats-Unis ont un bâti chiffré à 0,47 hag, la France à 0,17 hag et le Sénégal à 0,04 hag. Ces données n'informent pas sur le dépassement des limites écologiques par ces pays vu leur compensation parfaite par celles de la « biocapacité » bâti (selon le principe cidessus). Ces données ne contribuent donc pas à l'étude du dépassement des limites écologiques, mais à l'analyse du partage des ressources dans une perspective planétaire.	Generally, the more a country consumes, the more sizeable the built-up land areas become. The Unites States has 0.47 gha per person of built-up land, France has 0.17 gha per person and Senegal has 0.04 gha per person. These values do not inform us about the overshoot of the ecological limits of these countries, since built-up land biocapacity compensates perfectly for its Ecological Footprint. These data therefore do not contribute to understanding overshoot but rather to analysing the sharing of resources from a global viewpoint.	See above, where we explain how including built-up area links to overall demand on the biosphere and why the accounts are more complete when including this land use type.
9	1	Le tableau n°2 montre que la biocapacité planétaire est essentiellement constituée de quatre ressources (terres cultivées, herbages, forêts et pêches dont le total est de 1,78 hag) d'où notre emploi du terme de *biocapacité ressource*. Des trois premières ressources retenues, savoir les cultures, herbages et forêts, se dégage une balance écologique positive. En hectares globaux *per capita*, les cultures présentent une	Table 2 shows that global biocapacity essentially is made up of four resources (cropland, pasture land, forest land and fishing grounds, of which the total is 1.78 gha per person) hence our use of the term 'resource biocapacity'. For the first three resources, (crops, pastures, forests) we have a positive ecological reserve. In global hectares per capita, cropland represents an ecological reserve of 0.04 gha per person, pasture land 0.13 gha per person and	Yes, in net terms, according to the FAO figures that Global Footprint Network applies, it seems that these three areas are not exploited at full global capacity. This does not mean that they are free of local overshoot, but just means that in global aggregate they are not overused. Also note, that since we most likely err on the side of reporting too large a biocapacity and too small Footprints, in reality, humanity may be running a higher global deficit than our current numbers suggest.

		réserve écologique de 0,04, les herbages de 0,13 et les forêts de 0,55.	forest land 0.55 gha per person.	
9	1	Seules les pêcheries enregistrent une balance écologique négative (-0,01 hag) soit environ 1/14 de leur revenu écologique, un chiffre loin d'être aussi alarmant que les publications récentes sur le sujet laissent entendre.	Only fishing grounds have an ecological deficit (i.e., -0.01 gha per person). This is 1/14 of their ecological revenue, a number which is less alarming than analyses from many recent publications.	Fisheries are an area we are working on improving. We believe that our current assessment, based on FAO data, underestimates the pressure on fisheries: our results barely show a deficit in fisheries. This is why we are now looking for complementary data sets and better ways to assess demand and supply of fish.
9	1	Globalement, les quatre premières ressources naturelles présentent une balance écologique positive de 0,71 hag. Les craintes des fondateurs du GFN concernant le « goulet d'étranglement des ressources naturelles » ne sont pas confirmées par la méthodologie employée.	Globally, the four primary natural resources present a positive ecological reserve of 0.71 gha per person. The fears of the founders of Global Footprint Network concerning a natural resource bottleneck are simply not confirmed by the employed methodology.	First, even these four categories show massive use of global ecosystems by people – people being just one out of 10 million or so species. This is compounded by additional demands from waste emissions, mainly CO_2. If CO_2 was replaced by biofuels or we set space aside for providing the waste absorptive capacity, then global overshoot would become even more obvious. Moreover, please note that forests show a global overuse: the two demands on them – the area for CO_2 absorption and for timber extraction – exceed the area of forest globally available.
9	1	Cette cécité tient au mésusage du *Global Agro Ecological Zone* de la FAO dont le GFN s'est inspiré pour tous les écosystèmes. Concernant l'exploitation des forêts par exemple, l'empreinte compare les mètres cubes de bois retirés d'un espace forestier national avec le potentiel de production dudit pays. Elle ne fait pas la différence entre coupes claires et coupes réglées alors que ces dernières contribuent à la destruction des forêts, au détriment des générations futures.	This oversight depends on the misuse of the FAO's Global Agro Ecological Zone (GAEZ), which Global Footprint Network has used to compare ecosystem productivity. For forest exploitation, for example, the Footprint compares cubic meters of wood taken from a national forestry area with the production potential of the given country. The Footprint does not distinguish between clear-cutting techniques and selective harvesting. But the former contributes to the destruction of forest, to the detriment of future generations.	As a first approximation, it is useful to compare removal of m^3 of timber against m^3 of regeneration within a given time period. Poor and destructive harvesting techniques, will indeed, in addition, reduce future regeneration rates. However, there is no global data set to keep track of this phenomenon. In fact, FAO does not yet provide annually changing regeneration data. But in reality, forest productivity is changing over time. Ideally, countries would report forest productivity year after year, taking into account forest practice, climate, etc. In this way, current Footprint accounts are limited by the available data sets, not by concepts or methodological shortcomings. Note that the current approach leads to an overestimate of the biocapacity. In other words, our assessments most likely underestimate humanity's overuse.
10	1	L'inégalité envers celles-ci a certes des liens sur le plan sociologique avec un partage inégalitaire des produits d'une coupe claire, mais ces deux problématiques ne peuvent être confondues dès lors que l'on prétend quantifier une « physique » du	This inequality certainly has sociological links with the unequal share of the products of clear cutting, but these two issues cannot be confused if we aim to quantify the physical reality of overshoot. Global Footprint Network leads us to believe	It is not clear to us what the authors believe is being confused, and what inequitable resource use has to do with clear cutting. Further, discussing the name of the accounting tool is a subjective rather than scientific argument. A name is just an identifier for the underlying research question. The Ecological Footprint is defined as the answer to the research question: *how much of regenerative capacity of the biosphere is occupied by human activity?*

		dépassement des limites écologiques planétaires. Le GFN laisse accroire qu'il contribue à la mesure d'une *empreinte* – signe d'une marque durable voire irréversible – alors que sa méthodologie lui fait faire autre chose.	that they contribute to Footprint results, a mark that is lasting and maybe even irreversible, even though their methodology shows quite the opposite.	In addition, Ecological Footprint and biocapacity calculations, even as implemented currently, will eventually show the impact of poor management practice (which will manifest accurately if official data is collected and reported accurately).
10	2	*Une empreinte carbone basée sur un taux de séquestration arbitraire* ? Du fait de cette incapacité à discerner la surexploitation des ressources naturelles, le calcul de l'empreinte carbone devient un enjeu majeur, d'autant qu'elle compte pour la moitié de l'empreinte totale. Les 1,06 hag *per capita* de l'empreinte carbone du tableau 2 sont calculés à partir d'émissions nettes de 5 gigatonnes de carbone par hectare et par année (5 GtCan-1). Ce chiffre de 1,06 hag *per capita* a cependant quelque chose d'hypothétique puisqu'il indique un espace biologiquement productif qu'il faudrait avoir à disposition, un espace non existant, un *potentiel*.	*Is a carbon Footprint based upon an arbitrary sequestration rate?* Due to inability to discern the overexploitation of natural resources, the calculation of the carbon Footprint becomes a major challenge, especially because it accounts for half of the total Footprint. The 1.06 gha per capita for the carbon Footprint (table 2) are calculated based on the net emissions of 5 gigatonnes of carbon per hectare per year (5 Gt C yr^{-1}). This number of 1.06 gha per capita is nevertheless somewhat hypothetical since it indicates a biologically productive area which should be available - i.e. a non-existent space or a potential.	Calling the carbon Footprint "hypothetical" is one of the most common misunderstandings of Ecological Footprint accounting dating back to an article by van den Bergh and Verbruggen. In their 1999 article, they called the carbon Footprint in excess of biocapacity "hypothetical". In our Ecological Footprint accounts, we show that humanity demands more global hectares than are available whenever it harvests resources faster than they regenerate. This is "overshoot", it is not hypothetical. For instance, harvesting 10 hectares of forest for timber at 50 percent above its regeneration rate is shown as demanding the equivalent of 15 hectares worth of forest production. The missing 5 hectares of forest land is not "hypothetical." Rather it measures the extent of overshoot. Hence Ecological Footprint accounting compares actual available capacity with actual human demand. Similar to demanding forest for timber, CO_2 emissions represent actual, physical waste products released into the biosphere that demand sequestration capacity. The amount of carbon that can be sequestered per hectare of global forest can be analyzed from a number of perspectives, but we believe our estimates, based on United Nations Food and Agriculture Organization and IPCC accounting methods are the most widely accepted sources. Also see the discussion above regarding the accurate framework for conceptualizing the carbon sequestration factor.
10	2	La case vide du tableau 2 indique d'ailleurs que la biocapacité carbone n'a pas été calculée alors que la communauté scientifique avait établi – avant l'écriture du *Rapport planète vivante 2006* – que l'espace terrestre séquestrait 1,2 Gt/an. Cette omission empêche de faire coïncider les totaux en ligne et en colonne selon les règles généralement appliquées aux tableaux contenant des données exprimées dans une unité standardisée et, par ricochet, suscite un premier doute quant à la solidité du calcul de l'empreinte carbone.	The empty box of table 2 indicates that the carbon biocapacity has not been calculated. Yet the scientific community (before the writing of the Living Planet Report 2006) established that 1.2 Gt/yr of carbon were sequestered by the total terrestrial area. This omission means that it is impossible to make the total of each line and column correspond according to the rules that are generally applied to tables containing data expressed in standardized units. This leads to further doubts concerning the robustness of the	There is a difference between permanent sequestration and transition sequestration: if forests sequester carbon (as in temperate areas) but are doing this for future harvest, then this is not permanent sequestration. Sequestration can only be counted if there is a commitment to not harvest the maturing forest that is absorbing carbon. Therefore, if data were available, the biocapacity of forests dedicated to timber production could be compared with the forest Footprint while those dedicated to sequestration of carbon could be compared to the carbon Footprint.

			carbon Footprint calculation.	
10	3	Le GFN affirma dès l'origine que l'empreinte des énergies fossiles peut être estimée de différentes manières : soit en évaluant la surface de forêts nécessaire pour absorber le carbone d'origine anthropique, soit en évaluant la surface biologiquement productive capable de produire une quantité d'énergie équivalente aux énergies fossiles utilisées. Ces différentes approches diffèrent considérablement puisque la productivité du sol énergétique – tel qu'appelé alors – variait d'un facteur 1 à 5 suivant l'option retenue. Le GFN opta pour l'approche basée sur le taux de séquestration du carbone.	Global Footprint Network affirms that the origin of the fossil fuel Footprint can be estimated in different ways: either by evaluating the forest surface area necessary to absorbed anthropogenic carbon, or by evaluating the biological surface area capable of producing an quantity of energy equivalent to the fossil fuel energy used. These approaches differ considerably since the productivity of so-called 'energetic land' varies by a factor of 1 to 5 depending on the chosen method. Global Footprint Network opted for the carbon sequestration rate approach.	The carbon sequestration approach, which measures emissions of carbon dioxide from fossil fuel burning (minus what is absorbed by oceans) is expressed in terms of the total area, (in global hectares), required to sequester these carbon emissions. This is the most consistent approach when moving forward from the research question. It means balancing out ecological debts. Taking other approaches can provide a reality check and sensitivity analysis. At current carbon emission rates from fossil fuel, it would be theoretically possible to sequester all the excess carbon if a significantly large portion of the biocapacity of the planet were dedicated to sequestration. But then, significantly less would be available for timber production, potato and cereal growing, etc. So timber harvest, potatoes and carbon sequestration are in mutual competition for biocapacity.
10	3	Aujourd'hui, le GFN opte pour une rotation des coupes de 100 ans et estime ainsi que les 3,6 milliards d'hectares de forêts dénombrés ont un taux moyen de séquestration de 1 tonne de carbone par hectare et par an (1 tCha-1an-1).	Today, Global Footprint Network opts for a 100 year rotation cycle for clear-cutting and thereby estimates that 3.6 billion hectares of forest have a mean sequestration rate of 1 ton of carbon per hectare per year (1 t C ha^{-1} yr^{-1}).	Our estimates for the average sequestration rate calculate both 40 year and 100 year rotation rates, and find that the global average results we generated are quite robust and within a far more narrow range than the one suggested by the authors. Also note that rotation rates do not necessarily suggest clear-cuts. Rather they indicate the average time between total stock harvests (even if harvest occurs in continuous selective cuts).
10	3	Ce choix ignore cependant les émissions de carbone de la matière organique en décomposition (respiration hétérotrophe). Il fait de plus l'impasse sur la dégradation des biens économiques issus des forêts : la demi-vie du papier est située entre deux et cinq ans, celle des divers produits en bois entre 30 et 100 ans, ce qui signifie que la moitié du bois retiré des forêts – bien que transformé – émettra à nouveau du carbone dans un avenir proche (à l'échelle des changements climatiques).	This choice, however, ignores the carbon emissions from the decomposition of organic matter (heterotrophic respiration). It also completely overlooks the degradation of the economic assets from forests: the half-life of paper is between two and five years, and that of many wood products is between 30 and 100 years. This implies that half of the wood taken from forests, even if processed, will reemit carbon in the near future (on a the scale of climatic change).	This is incorrect. The area occupied for forest products reabsorbs the CO_2 that is emitted by the forest products, therefore providing a zero balance in the carbon cycle as reported in the literature (e.g., González, M.J. and Navarro, J.G. 2006; Bastianoni et al., 2007). When assuming that energy expenditures from the use of natural products, such as timber and cork, are compensated by the absorption of CO_2 by trees during their growth, these materials would be carbon neutral: no additional carbon is added to the carbon cycle. CO_2 emission and absorption rates are within the same temporal scale. In contrast, CO_2 from the burning of fossil fuels accumulates in the atmosphere due to the different time scales of natural production of fossil fuels and human consumption (million of years of production versus decades of consumption). Therefore, we only account for the carbon newly added to the carbon cycle through anthropogenic activities. According to studies from the US Forest service, the emission of carbon

				from harvested timber products is even more rapid than suggested by the authors. This is why in our accounts timber production and carbon sequestration are considered to be two competing uses of forest ecosystems (i.e., according to current practice, only one or the other use is possible – the uses are in direct competition).
11	2	Afin d'éprouver la sensibilité de cet indicateur au taux de séquestration, nous avons calculé l'empreinte écologique totale (empreinte carbone et empreinte ressource) de différents ensembles continentaux. Nous avons recouru pour cela à différents taux de séquestration, eux aussi potentiels, savoir ceux des forêts cultivées (plus élevés que celui retenu par le GFN) et un taux plus bas (0,3 tCha-1an-1) calculé à partir des chiffres de la surface des forêts planétaires et du carbone effectivement séquestré par l'espace terrestre.	To test the Footprint's to the sequestration rate, we have calculated the total Ecological Footprint (carbon Footprint and resource Footprint) of different continental groupings. For this, we used different sequestration rates, which are also potential rates: for example, cultivated forest sequestration rates (higher than those used by Global Footprint Network) as well as a lower rate (0.3 t C ha^{-1} yr^{-1}) based on the global forests surface area and the carbon effectively sequestered by terrestrial land area.	Sensitivity analyses only provide additional information if they are based on sound methodological reasons for choosing a range of input parameters. In this case, we do not believe it is logical to use effective carbon sequestration per hectare based on world-average land use patterns in the carbon Footprint calculations. Footprint accounts document actual occurrences: in the case of sequestration, they document actual average sequestration rates. It is incorrect to use an average number as an estimate of what is possible if everything were forest plantations. It is also incorrect to use the average sequestration of current forests. The latter is incorrect because it ignores that much of the forest surface is dedicated to timber production (which is at best carbon neutral, but certainly not a sink). Therefore, our approach measures how much an average forest hectare can sequester (expressed in an annual per global hectare basis). What the current actual forest hectare does provide (sequestration or timber) depends on what the hectare is used for. If it is designated for timber production, it does not sequester CO_2 in any permanent way. Therefore, calculating an average as suggested by Piguet et al. is inconsistent with the research question. The average sequestration calculated by Piguet et al. (i.e., 0.3 t C ha^{-1} yr^{-1}) is comparable to calculating average potato yields by dividing the world's potato harvest by the total area of cropland. Rather, to get the correct world average potato yield, one has to divide the world's potato harvest by the total area of cropland dedicated to potato growing. The same is true for sequestration. The sequestration yield for a given hectare is the CO_2 sequestration this hectare can provide if dedicated to sequestration, not all occurring sequestration, divided by all forest areas. In other words, Piguet et al.'s error is a mismatch of categories.
11	3	Le graphique 2 est tronqué au niveau de l'ordonnée (l'empreinte de 20,5 hag de l'Amérique du Nord n'apparaît pas). Il montre les changements de « hiérarchie écologique » des ensembles continentaux suivant le taux de séquestration retenu et subsidiairement que ces ensembles s'éloignent ou se rapprochent de la norme des 1,78 hag per capita (ci-après arrondi à 1,8 hag). Il y a donc deux phénomènes distincts, le changement dans la hiérarchie écologique semblant être le plus	Figure 2 has a truncated y-axis (the Footprint of 20.5 gha for North America does not appear). It shows the changes in the ecological hierarchy of the continental groupings according to the chosen sequestration rate, but also shows how these groupings approach or move away from the 1.78 gha per capita benchmark (hereafter rounded to 1.8 gha per capita). Therefore there are two distinct phenomena the change in ecological hierarchy being the most interesting. The position of Latin America and the Caribbean	Yes, the assessment is sensitive to the overall carbon number. We acknowledge that more detailed work could be done, and have identified this as a priority ourselves. However, we doubt that the average we have calculated is as far off from a revised assessment as Piguet et al. assume. We have done a number of estimates with a significantly smaller range. Moreover, by definition, the Footprint accounts for the bioproductive area required to produce the resources people use and absorb the wastes that people emit. Since people use resources from all over the world, and affect distant places with their pollution (e.g., climatic change is a global rather than local phenomenon), the Footprint is the sum of these areas wherever they are on the planet. This rationale suggests calculating the carbon Footprint using a global average rather than a local specific forest hectare sequestration rate, with the Footprint values therefore depending on the amount of CO_2 released and not on local sequestration

		intéressant. La place de Amérique latine & Caraïbes varie relativement aux autres espaces continentaux : avec un taux de séquestration de 2,5 tCha-1an-1 son empreinte per capita est supérieure à celle de Moyen-Orient & Asie centrale et inférieure à la moyenne mondiale ; avec un taux de 1 tCha-1an-1, Amérique latine & Caraïbes apparaît à l'inverse plus « écologique » que l'entité à laquelle elle vient d'être comparée, mais elle se situe en dessus de la moyenne mondiale. Sans entrer dans le détail, ce type de changement vaut aussi concernant Moyen-Orient & Asie centrale pour un taux de 0,3 tCha-1an-1, et pour Afrique et Asie-Pacifique à un taux de 3,5 tCha-1an-1. En revanche, la « hiérarchie écologique » de Union européenne, Europe non UE et Amérique du Nord n'est pas modifiée. Cette importante sensibilité au taux de séquestration invalide le mode de conversion des tonnes de carbone en hectares globaux. Cet avis est indirectement confirmé par le non calcul de la biocapacité carbone. Cette biocapacité équivaudrait en effet à la biocapacité ressource quel que soit le taux de séquestration du carbone effectivement constaté. La biocapacité carbone d'un espace donné a la même valeur que sa biocapacité ressource, quel que soit le taux de séquestration de cet espace. Que le taux de séquestration des forêts s'établisse à 0,3 t C ha-1 an ou à 1 t C ha-1 an, la biocapacité carbone ne varie pas. À l'échelle des 3,6 Gha de forêts mondiales, la	varies in relation to other continental areas: with a sequestration rate of 2.5 t C ha^{-1} yr^{-1} its per capita Footprint is greater than that of the Middle East and Central Asia and smaller than the world average; with a sequestration rate of 1 t C ha^{-1} yr^{-1}. The region of Latin America and the Caribbean seems to be more "ecological" than the entity with which it was just compared, and yet it finds itself below the world average. Without entering into too much detail, this type of variation also applies to the Middle East and Central Asia with a sequestration rate of 0.3 t C ha^{-1} yr^{-1}. However the ecological hierarchy of the European Union, non EU Europe and North America is not modified. This important lack of sensitivity to changes in sequestration rates invalidates the conversion method from tons of carbon to global hectares. This error is indirectly confirmed by the non-calculation of carbon biocapacity.: this biocapacity is effectively equivalent to the resource biocapacity regardless of the carbon sequestration rate chosen. The carbon biocapacity of a given area has the same value as the resource biocapacity, regardless of the carbon sequestration rate of that area. Whether the forest sequestration rate is set to 0.3 or 1 t C ha^{-1} yr^{-1}, carbon biocapacity does not vary. Using the 3.6 billion ha value of global forests, the carbon biocapacity value, which Global Footprint Network refuses to publicize, would amount to 0.78 gha per capita. Lacking a non-artificial evaluation of the carbon biocapacity, and taking into account the other	capacity. However, changing local sequestration capacities will show up in the biocapacity of this country. Further, the carbon Footprint is just one component of the overall Footprint (which is made up of cropland Footprint, grazing land Footprint, forest Footprint, fisheries Footprint, built-up Footprint, and carbon Footprint). Therefore, it is obvious that in regions where carbon Footprint only accounts for a small percentage of the total value (such as 25% of the total), such sensitivity is different from that of other groupings where carbon Footprint accounts for over half of the overall Footprint value. See also the answer provided above for further explanation.

		biocapacité carbone que le GFN s'est refusé à chiffrer s'élèverait à 0,78 hag per capita. Faute de pouvoir évaluer la biocapacité carbone de manière non artificielle, et compte tenu des autres raisons déjà invoquées, le déficit écologique planétaire de 0,45 hag ne peut être tenu pour fondé.	already cited reasons, the ecological deficit of 0.45 gha per capita cannot be considered well-founded.	
12	3	*Une empreinte écologique réduite à sa seule empreinte carbone ?* Le graphique 3 décompose l'empreinte écologique des ensembles continentaux en deux parties : l'empreinte carbone (en noir) et l'empreinte non carbone – essentiellement constituée des ressources renouvelables (en gris). Il a été précédemment établi que les chances d'identifier les dommages portés aux ressources renouvelables sont fortement diminuées par la méthodologie du GFN, de quoi il découle que le déficit écologique constaté est uniquement dû à l'empreinte carbone.	*Can the Ecological Footprint be reduced down to its carbon Footprint?* Figure 3 separates the Ecological Footprint into two main categories by continental groupings: the carbon Footprint (in black) and the non-carbon Footprint –essentially made up of renewable resources (in grey). It has already been established that any damages brought to renewable resources are underplayed by Global Footprint Networks methodology, and thus the recognized ecological deficit is uniquely due to the carbon Footprint.	The carbon Footprint is over half of the global Ecological Footprint, but its contribution varies considerably among nations. While contributing significantly to the Footprint of nations such as USA or UAE, the carbon Footprint represents just a small contribution in, for example, Uruguay or Gabon. Therefore reducing the whole accounting system to just the carbon Footprint would be inaccurate for national Footprint applications. It is further inaccurate to claim that the deficit is only due to the carbon Footprint, as it is the combination of the demands on all the land types that leads to a Footprint in excess of the planet's biocapacity.
13	1	Bien que le déficit écologique rapporté par le GFN soit seulement dû à l'empreinte carbone, l'agrégation en hectares globaux défend de simplement mettre en débat la question éthique soulevée par les personnalités ci-dessus.	Although the ecological deficit reported by Global Footprint Network is only due to the carbon Footprint, the aggregation into global hectares simply pushes the ethical debate raised by Global Footprint Network.	The overall demand expressed by the Ecological Footprint is a combination of various demands, not just carbon. If a country emits CO_2 and has enough biocapacity to absorb it, it could opt to sequester its CO_2. Thereby it would neither put any demand on the atmosphere nor require sequestration capacity from other countries. How this criticism links to ethical propositions is not clear. Essentially, the Ecological Footprint is a descriptive tool. Interpretation of the results is up to the user.
13	1	En effet, le partage des ressources renouvelables correctement exploitées ne peut être égalitaire, *a fortiori* lorsque des populations éloignées bénéficient de ressources dissemblables (on voit mal les	In reality, the sharing of sustainably extracted renewable resources cannot be equal -- i.e., when geographically separated populations benefit from each other's resources (we hardly see the Egyptians asking the Canadians	This again is a confusion of the Footprint's description versus interpretations about allocation rights (which the Footprint does not provide). The Footprint is not determining allocation rights, but rather just describes what is.

		Egyptiens demander aux Canadiens de partager leurs produits forestiers sur une base égalitaire). Exiger le partage des ressources gérées correctement sur une base égalitaire apparaît infondé et vain, alors même que la question de l'égalité stricte est légitime pour la partie carbone de l'empreinte.	to share their forests on an equal basis). To demand the sharing of correctly managed resources on an equal basis appears unfounded and unlikely, especially when the question of strict equality is legitimate for the carbon portion of the Footprint.	
13	2	L'empreinte induit le public en erreur sur la seule cause de dérèglement de la planète qu'elle met en évidence. Elle indique qu'il faut seulement trois planètes en cas de généralisation du mode de vie moyen des Français (5,6 hag / 1,8 hag = 3,1) mais quatre planètes sont indispensables si chaque Terrien émet autant de carbone qu'eux (2 tC / 0,5 tC = 4).	The Footprint leads the public astray by proposing a single cause for the disruption of our planet for which it provides evidence. It indicates that we would need three planets if everybody in the world adopted a French lifestyle (5.6 gha per person / 1.8 gha per person = 3.1) however four planets would be necessary if each person in the world produced as much carbon as a Frenchman (2 tC / 0,5 tC = 4).	Many sources quote the 0.5 t carbon emission per person and year (or 1.8 t of CO_2) as the greenhouse gas amount that could be emitted presently without further increasing the CO_2 concentration in the atmosphere (assuming no other land-use, productivity, and population change). While this number is consistent with our accounts, we do not use it as a reference point. Rather we compare the overall demand of humanity (for carbon sequestration, timber, food etc.) against overall biocapacity. We do not agree that dividing the amount of carbon emissions per person by the 0.5 t of carbon per person and year can be interpreted as "number of planets necessary if everybody lived like this person**."** On the contrary, this only tells us by how much the country would need to cut its emissions to be within the possible global per capita allotment (assuming no other land-use changes). This ratio is something quite distinct from the number of planets we can calculate with the Footprint since carbon from fossil fuel is just one human demand on the planet. The only way to draw such conclusions as to how many planets are necessary in the aggregate, considering all land types, is to perform an analysis that considers all land types. Accounting only for carbon ignores the potential for substitution between land types or for changing management practices. This carbon ratio thus in no way accurately reflects the "number of planets" necessary, and cannot be directly compared to our estimate of "number of planets used by humanity" or "numbers of planets used if everybody lived like a given person". The reason is simple: the carbon sequestration service is just one of many other services nature provides.
		L'empreinte écologique indique qu'il faut cinq planètes dans l'éventualité de la planétisation du mode de vie nord-Américain (9,6 hag / 1,8 hag = 5,3) mais onze planètes sont nécessaires sous l'angle des émissions de carbone exprimées en tonnes (5,6 tC / 0,5 tC = 11,2).	The Ecological Footprint indicates that we would need 5 planets if everybody adopted an North-American lifestyle (9.6 gha/ 1.9 gha = 5.3) but 11 planets would be necessary from a carbon emissions perspective, expressed in tons (5.6 t C / 0.5 t C = 11.2).	The authors commit same error as discussed above.

13	2	Les hectares globaux réduisent arbitrairement la responsabilité de nombreux États quant aux changements climatiques et ils fournissent une image biaisée des efforts qui devraient être consentis. Le GFN distribue d'ailleurs des *satisfecit* à des pays telles l'Algérie ou la Chine, 1,6 hag *per capita* chacun (en dessous des 1,8 hag de la biocapacité planétaire moyenne) ; ces données occultent toutefois le niveau trop élevé des émissions de carbone de ces pays pour représenter un modèle à suivre : les émissions de la Chine dépassent de moitié les montants généralisables sur le long terme (0,76 tC / 0,5 tC = 1,5) et celles de l'Algérie les excèdent de plus des deux tiers (0,85 tC / 0,5 tC = 1,7).	Global hectares arbitrarily reduce the responsibility of numerous states with regard to climate change and provide a biased picture of their efforts that should be made. Global Footprint Network furthermore congratulates countries such as Algeria or China with 1.6 gha per capita each (below the 1.8 gha world average biocapacity); these data nevertheless hide the high carbon emissions levels of these countries and show them as being exemplary: China exceeds by over 50% the recommended long term levels (0.76 t C / 0.5 t C = 1.5) and Algeria exceeds these levels by more than two thirds ((0.85 t C / 0.5 t C = 1,7).	This statement is incorrect. We do not allocate responsibility, but measure how much biocapacity is used and available. We are not indicating any carbon reduction numbers. However, we show that there is a trade-off between producing more timber and less carbon sequestration or vice versa. This trade-off is consistent with ecological reality -- carbon is not an independent silo. Also, nothing about carbon emissions is hidden by Footprint accounts. All the numbers are included transparently in the accounts, and they are consistent with UN data sets. Moreover, while China has a less than world average Footprint, it has a large population. China is now demanding more from the planet than any other nation except the United States, with most of this demand (nearly 45%) due to its carbon Footprint. Carbon is a big part of the Footprint. But reducing the story of human demand on the biosphere to carbon only, as suggested by the authors, is misleading.
14	1	Les tableaux du *Rapport planète vivante 2006* véhiculent une géographie équivoque du respect des limites de la planète alors même que les émissions de carbone sont la seule cause de déficit écologique que sa méthodologie lui permet de discerner.	The tables in the Living Planet Report 2006 promote a geography of planetary limits, even when carbon emissions are the only cause of the ecological deficit that is evidenced by the methodology.	This is a misinterpretation. Overshoot is the aggregate of many components - all of the demand adds up against of all the supply. If less of the original forest were cropland, and less timber were harvested, we would have more capacity for carbon sequestration. (50% of the original forest area is lost,)
		Exprimer ces émissions en tonnes éclaire de manière incomparablement plus précise le débat sur l'assignation des responsabilités écologiques, et cela pour trois raisons au moins :	To express these emissions in tons clarifies, in an incomparably more precise manner, the debate concerning the assignation of ecological responsibilities for the following:	There is nothing lost in our data set. In fact, it is totally consistent with tones as a unit of measure, but we also translate the tonnes into a unit that can be compared with other demands on nature. Further, the impact per tonne of carbon is changing. The Footprint captures this while the tonne alone does not. See also below.
14	3	1° Un inventaire en tonnes est plus solide sur le plan scientifique car il évite les difficultés insurmontables d'une empreinte carbone exprimée en hectares globaux (la détermination d'un taux de séquestration non arbitraire relativement à un espace non	1) An inventory in tons is more solid scientifically since it avoids the insurmountable difficulties of the carbon Footprint expressed in global hectares (the determination of a non-arbitrary sequestration rate relative to a non-arbitrary land area is not an objective procedure). Once these	The impact per tonne of carbon is not the only thing to consider; you also have to compare it against the available demand. Further, the impact per tonne of carbon is changing. The Footprint captures this, and the tonne alone does not. Our sequestration and land areas are not arbitrary, but computed directly from FAO data sets. The calculation we made from the FAO data set is available for download on our website.

		arbitraire n'est plus un objectif à réaliser). Une fois ces problèmes méthodologiques contournés, il reste davantage de temps pour traiter des problèmes réels liés à l'inventaire des flux de carbone et de leur mise à jour.	methodological problems are overcome, there is more time to treat real problems linked to the inventory of carbon fluxes and their updating.	Also, why is the impact of each tonne of carbon changing? A more carbon-constrained world has less capacity to deal with each additional tonne, which makes climate impacts more severe per tonne, and we'll be running out of biological sequestration capacity. Furthermore, there can be positive feedback loops at play, which accelerate impact. Examples include the reduced ability of oceans to absorb CO_2, or melting permafrost releasing additional greenhouse gases.
14	4	2° Grâce à un inventaire en tonnes de carbone, la problématique scientifique est clarifiée, et la problématique éthique cesse d'être confuse.	2) Thanks to an inventory of carbon in tonnes, the scientific issue is clarified and the ethical issue ceases to be confusing.	None of the information is lost in Footprint accounts. All the necessary information on tones of carbon emitted is still available. Further, in addition to tonnes of carbon, we consider it scientifically significant to understand whether the demand on nature of one tonne of carbon is increasing or decreasing. Also having sound accounts of demand on and supply of nature makes negotiations clearer and cleaner, not more confusing.
14	4	Ce gain en transparence permet de mettre en cohérence les plans politique, pédagogique et médiatique. L'atout en matière de décision politique est évident puisque les discussions sont directement basées sur les données scientifiques. Exprimée en tonnes, l'empreinte carbone représente 219% de la capacité de séquestration de la Biosphère (6,8 GtC / 3,1 GtC = 219%) un chiffre sans rapport avec celui du GFN indiquant que l'empreinte écologique de l'humanité équivaut à 125% de la biocapacité planétaire.	This gain in transparency permits increased coherence on a political, pedagogical and media/communications level. The advantage for political decision-making is evident since discussions are directly based on scientific data. Expressed in tons, the carbon Footprint represents 219% of the biospheres sequestration capacity (6.8 Gtc/ 3.1 Gtc =219 %) -- a very different number to Global Footprint Network's value, which indicates that humanity's Ecological Footprint equals 125% of global biocapacity.	The authors seem to be confusing carbon with Footprint. As stated above, we can emit more carbon if we allocate more of the land area to sequestration and less to food and timber production. Consider of the trade-offs with biofuels, for example. Again, producing less food and sequestering more carbon is not what we advocate, but this trade-off between various land-uses is an ecological reality, which the Footprint adequately describes. Hence, the 219% number for carbon overshoot and the 125% number for overall overshoot (in 2003) are absolutely consistent.
14	4	Notre manière de voir autorise la discussion scientifique et éthique sur un enjeu environnemental majeur. Sur le plan pédagogique, les tonnes de carbone permettent d'aborder les problèmes sur une base claire – exempte de questions méthodologiques parasites – sachant que des liens avec les enjeux moraux et politiques peuvent être établis à tout instant.	Our point of view allows for a scientific and ethical discussion of the major environmental factors at play. From a pedagogical perspective the expression of carbon in tonnes allows us to approach these problems from a clear starting point - exempt from nit-picky methodological questions- and acknowledging that moral and political factors may come into play at any time.	These statements again are erroneous in their confusion of the Footprint with carbon measures. Again, Footprint is a description, not a normative tool. Like a banker, we need solid accounts to understand our assets, our income and expenditure. Solid accounts then can support political processes.
14	4	L'écologie peut alors être enseignée à partir d'informations correctes, débarrassée de la croyance implicite	Ecology can therefore be taught based on correct information, free from the implicit belief in the partial	There is no such belief underlying Footprint accounting. We are merely linking carbon accounting with other demands on the biosphere, and thus documenting competing uses of limited biocapacity. Clearly, not all other reserves can compensate for carbon

		en la compensation partielle de l'empreinte carbone par une balance ressources positive.	compensation of the carbon Footprint by a positive reserve of other resources.	deficits -- a smaller fish harvest does not compensate for higher timber harvest, for example. But converting cropland back to permanent (non-harvested) forests would serve as a carbon sink. Also note: humanity having a Footprint smaller than the biosphere is a necessary, but not sufficient condition for sustainability. Also, we are not arguing that the various natural capital components are fully substitutable, but that they are in competition.
14	4	Sur le plan médiatique, rien n'empêche d'employer les formules appréciées des thuriféraires de l'empreinte. En d'autres termes, malgré une empreinte carbone exprimée en tonnes, il est toujours envisageable d'être percutant : « Les émissions annuelles mondiales de carbone saturent déjà la capacité de séquestration planétaire le 169e jour de l'année (18 juin) » « Si chaque habitant de la Terre émettait autant de carbone qu'un Britannique moyen, il faudrait sept planètes pour séquestrer ses émissions (3,28 tC / 0,5 tC = 6,6). »	From a media perspective, nothing stops the use of the common formulas used by Footprint enthusiasts. In other words, despite the carbon Footprint being expressed in tonnes, it is still possible to send out a hard-hitting message: "Average global carbon emissions saturate the planetary sequestration capacity on the 169th day of the year (18th of June)" "If every inhabitant of the Earth emitted as much carbon as an average Briton, we would need seven planets to sequester the total emissions (3.28 tC / 0.5 tC = 6.6)".	This comparison assumes we only get carbon sequestration from the Earth, while in reality people are competing for many more services provided by the biosphere. Carbon alone is not the answer to the question of how much more Footprint than biocapacity is being used. We can choose whether we want to make more sequestration capacity available or harvest more timber products, or reduce the forest area and have more cropland. The need for understanding these trade-offs is particularly important when considering the ecological impacts of biofuels.
14	5	3° Le méthane et les halocarbures contribuent au réchauffement climatique avec des *forçages radiatifs* en watts par m2 de respectivement 0,48 et 0,34 contre 1,66 pour le dioxyde de carbone (d'après leurs importances respectives dans l'atmosphère) 38. Leur traduction en hectares globaux serait forcément arbitraire.	3) Methane and ozone depleting substances contribute to climate warming with radiative forcing, in Watts/m2 of 0.48 and 0.34 respectively, compared to 1.66 for carbon dioxide (according to their respective importance in the atmosphere). Their translation into global hectares would inevitably be arbitrary.	We have not included other greenhouse gases at this point. This is being discussed in our National Footprint Accounts committee. Again, including other gases would increase the Footprint, which is consistent with our claim that it is a conservative measure.
14	5	En revanche, une empreinte carbone exprimée en tonnes de carbone peut être agrégée avec ces gaz (moyennant conversion en dioxyde de carbone équivalent en tenant compte de leurs forçages radiatifs relatifs). Il devient alors envisageable de rapporter ces gaz à effet de serre à la consommation des	On the other hand a carbon Footprint expressed in tonnes of carbon could be aggregated with gases (by averaging their conversion to a carbon dioxide equivalent and taking into account their relative irradiative forcings). It therefore becomes foreseeable to report these greenhouse gases to the consumption	This effect is traceable: once the basic Footprint is established, one can further investigate which part of the Footprint are restorative uses, or depleting uses. The implementation procedure initiated by Global Footprint Network, considers how to include these elements in the National Footprint Accounts (Kitzes et. al, 2007). However, it should be noticed that no indicator alone is sufficient to assess sustainability, and we have never proposed the Footprint as a stand-alone indicator. In

		différents pays. Ces trois critiques et les propositions associées nous semblent pouvoir contribuer à l'analyse de la structure de la consommation et de son influence délétère. Le calcul de l'empreinte carbone en tonnes est indispensable au débat écologique et nous espérons que le GFN pourra poursuivre ce travail en lui adjoignant les émissions de méthane et d'halocarbures, voire de protoxyde d'azote. Quant aux ressources surexploitées, elles doivent être inventoriées selon leur provenance et le type de dommage : érosion des sols, coupes réglées, surpêche, etc.	of different countries. These three criticisms and the associated propositions may contribute to the analysis of consumption structure and its deleterious influence. The calculation of the carbon Footprint in tonnes is indispensable to the ecological debate and we hope that Global Footprint Network will continue this work by adding methane and halocarbon emissions, and possible nitrous oxide as well. As for overexploited resources, they must be inventoried according to their origin and the type of damage they cause: soil erosion, selective harvest, overfishing, etc.	fact, Ecological Footprint Standards explicitly state that the Footprint only addresses one aspect of sustainability and needs to be complemented by other indicators.
15	1	L'avenir est à la labellisation des marchandises provenant de ressources correctement gérées, et au contrôle voire à l'interdiction de l'exportation et de l'importation de celles provenant de ressources gravement surexploitées. Tracer les limites écologiques de la planète implique de travailler prioritairement sur les flux de matière (au sens large) sachant que leur agrégation nécessite le respect de certaines règles, comme n'agréger que des flux ayant des effets semblables, sur des zones déterminées de manière cohérente, selon l'échelle appropriée. Évaluer des flux entre pleinement dans le champ de l'écologie industrielle. Pareille démarche permet de clarifier les enjeux réels sachant que l'écologie n'est pas telle qu'elle pourrait profiter d'un indicateur synthétique.	The future lies in the labeling of merchandise that originates from correctly managed resources, and possibly even in the banning of the exports of products from severely overexploited resources. Tracing the ecological limits of the planet implies working primarily on material flux (broadly speaking) and knowing that their aggregation requires respecting certain rules, like such as only aggregating fluxes with similar effects within clearly defined zones and according to appropriate scales. Fully evaluating fluxes enters into the realm of industrial ecology. This process would permit the clarification of the real ecological stakes, bearing in mind that the study of ecology would not benefit from a synthetic indicator.	If bears could plan for their habitat conservation, they would like to know how much of the biocapacity of the planet people use, and how much is left for bears and other wild species. Certainly, for conservationists, it is useful to know how much of the biosphere is being occupied. This is why WWF, the world's largest conservation organization, is working closely with us. We never say that the Footprint is the most appropriate tool for managing particular ecosystems. It is merely a tool to put the various pressures on nature in context with each other. We need to recognize that we face intertwined environmental challenges. It is no coincidence that these ecological crises of soil depletion, fisheries collapse, deforestation, overuse of water, etc. are all happening at the same time. They are symptoms of a larger issue: humanity's metabolism is getting too big for the biosphere.

15	2	De manière générale, les défauts de l'empreinte mis en évidence dans ces pages relèvent tous de la confusion éthique concernant les questions de partage entre contemporains avec les questions de destruction des qualités de la nature au détriment des générations futures.	Generally, the defects of the Footprint revealed here raise the ethical confusion between questions of resource sharing between peoples and questions of the destruction of natural capital, to the detriment of future generations.	The Footprint is descriptive, not normative. The same is true for the description of the biocapacity distribution across the world. By tracking both Footprint and biocapacity, Footprint accounts documents human demand against ecological availability. Documenting to what extent humanity lives on and exceeds nature's income directly supports understanding the conflict between present and future generations.
15	2	Par son origine, l'unité hectare global évoque les hectares servant à quantifier la propriété foncière, et elle soulève logiquement la question du partage entre contemporains (voire de l'espace vital). Les défauts de l'empreinte proviennent de l'association irréfléchie de ces deux perspectives, ils ne peuvent aucunement être résolus par un surcroît de précision dans les données. L'unité hectare global ne peut rendre compte des émissions de carbone, son abandon paraît logique… et devrait conférer une justesse minimale à l'indispensable métaphore d'empreinte écologique.	By its origin, the measurement unit of "global hectares" evokes this sense of land ownership and therefore raises the distribution question (compare also to the Nazi concept of "living space"). The Footprint's flaws come from the poorly thought out combination of these two perspectives. These cannot in any way be resolved by increases in data accuracy. The global hectare unit cannot account for carbon emissions, and so the only logical solution is to abandon the global hectare measurement concept. This would give some minimal justice to the indispensable metaphor the Ecological Footprint offers.	The Ecological Footprint is just a name. What it should or should not do can only be judged by looking at the research question it represents – that is, how much of the regenerative capacity of the biosphere is occupied by human activity. Secondly, since life happens on the surfaces of our planet, and competes for habitat surface, measuring biocapacity in terms of surface makes sense. According to the First Law of Thermodynamics, in fact, mass is neither created nor destroyed, but rather, everything that is extracted from the Earth gets transformed, distributed, consumed, thrown out and (eventually) deposited back in the ecosystem. Moreover, the science of analyzing Energy and material flows in ecosystems has underlined that resources flows are actually circular, with ecosystems absorbing the waste flows and transforming them back into resources through photosynthesis, thus counteracting entropic degradation. Since living systems on the Earth need a continuous flow of negative entropy (that is, energy from outside) and this flow consists of the very solar energy captured by photosynthesis, it makes sense to express a population's Ecological Footprint as the area continuously required to generate a quantity of photosynthetic biomass energy and material that is equivalent to the amount used and dissipated by the population's consumption. This method for measuring life-supporting natural capital reflects the fact that humanity is constrained by Earth's biophysical limits and thermodynamic constraints. The surface of the Earth is in fact finite, and the available ecologically productive area and annual amount of resources produced and wastes absorbed have to be finite as well. Therefore, measuring biocapacity in terms of surface makes thermodynamic sense. Adding up mutually exclusive demands on these surfaces, as done with the Ecological Footprint, is a sound methodology. Demands on ecosystem services include resource harvest (tonnes of carrots extracted) as well as waste emission (tonnes of waste emitted – such as CO_2) – when these services are in competition for space. Waste streams from the burning of fossil fuels are interfering with the biosphere, and not neutralizing a CO_2 build-up in the atmosphere is equivalent to leaving an ecological debt. We could plant more trees for carbon sequestration where we now grow carrots – but one of the two land uses has to give. (Technically, we could also increase the yields of carrot growing so much that we can still produce the amount of carrots and absorb CO_2 on

				the gained space.) Therefore, in spite of the claim of the authors, CO_2 emissions from the burning of fossil fuels are competing for Earth's limited ecological services, and hence need to be part of the overall equation. The debate around biofuels might illustrate most clearly that fossil fuel, land, and food issues are tightly interlinked.

REFERENCES

Galli, A., Kitzes, J., Wermer, P., Wackernagel, M., Niccolucci, V., Tiezzi, E., 2007. An Exploration of The Mathematics Behind The Ecological Footprint. International Journal of Ecodynamics. In press.

Kitzes, J., Galli, A, Bagliani, M., Barrett, J., Dige, G., Ede, S., Erb, K., Giljum, S., Haberl, H., Hails, C., Jungwirth, S., Lenzen, M., Lewis, K., Loh, J., Marchettini, N., Messinger, H., Milne, K., Moles, R., Monfreda, C., Moran, D., Nakano, K., Pyhälä, A., Rees, W., Simmons, C., Wackernagel, M., Wada, Y., Walsh, C. & Wiedmann, T., A Research Agenda for Improving National Ecological Footprint Accounts. Paper submitted to the International Ecological Footprint Conference - Stepping up the Pace: New Developments in Ecological Footprint Methodology, Policy & Practice, 8-10 May, Cardiff, 2007.

Galli, A., 2007. Assessing the role of the Ecological Footprint as Sustainability Indicator. PhD Thesis at the Department of Chemical and Biosystems Sciences, University of Siena

González, M.J. and Navarro, J.G. 2006. Assessment of the decrease of CO2 emissions in the construction field through the selection of materials: Practical case study of three houses of low environmental impact. Building and Environment 41, 902-909.2)

Bastianoni, S., Galli, A., Pulselli, R.M., Niccolucci, V. 2007. Environmental and economic evaluation of natural capital appropriation through building construction: practical case study in the Italian context. Ambio, 36(7), 559–565.